OROVILLE FERC RELICENSING
(PROJECT NO. 2100)

INTERIM REPORT
SP-F3.2 TASK 2
SP-F21 TASK 1

APPENDIX A
MATRIX OF LIFE HISTORY AND HABITAT REQUIREMENTS FOR FEATHER RIVER FISH SPECIES

LITERATURE REVIEW OF LIFE HISTORY AND HABITAT REQUIREMENTS FOR FEATHER RIVER FISH SPECIES

GREEN SUNFISH

JANUARY 2003

Element	Element Descriptor	General	Feather River Specific
General			
common name (s)	English name (usually used by fishers and laypeople).	Green Sunfish	
scientific name (s)	Latin name (referenced in scientific publications).	*Lepomis cyanellus*	
taxonomy (family)	Common name of the family to which they belong. Also indicate scientific family name.	Sunfish and Bass - *Centrarchidae*	
depiction	Illustration, drawing or photograph.		
range	Broad geographic distribution, specifying California distribution, as available.	Green sunfish are native to eastern and central North America, and introduced to the western states, including Utah, Nevada, and California (Wang 1986). Green sunfish are native to the Mississippi drainage system, including the Great Lakes, and are now in almost all of the United States, Germany, Korea, the Philippines, Morocco, South Africa, Swaziland, Brazil, and Mauritius (Moyle 2002).	
native or introduced	If introduced, indicate timing, location, and methods.	Green sunfish were originally introduced to California in San Diego County in 1891(Moyle 2002).	

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ESA listing status	Following the categories according to California Code of Regulations and the Federal Register, indicate whether: SE = State-listed Endangered; ST =State-listed Threatened; FE = Federally listed Endangered; FT = Federally-listed Threatened; SCE = State Candidate (Endangered); SCT = State candidate (Threatened); FPE = Federally proposed (Endangered); FPT = Federally proposed (Threatened); FPD = Federally proposed (Delisting); the date of listing; or N = not listed.	Green sunfish are not listed.	
species status	If native, whether: Extinct/extirpated; Threatened or Endangered; Special concern; Watch list; Stable or increasing. If introduced, whether: Extirpated (failed introduction); highly localized; Localized; Widespread and stable; Widespread and expanding.	The status of green sunfish is “widespread and stable” (Moyle 2002).	
economic or recreational value	Indicate whether target species sought for food or trophy. Whether desirable by recreational fishers, commercial fishers, or both.	Green sunfish are desirable by recreational fishers (Wang 1986).	
warmwater or coldwater	Warmwater if suitable temperature range is similar to basses; coldwater if suitable temperature range is similar to salmonids.	Green sunfish are a warmwater fish (Moyle 2002).	

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pelagic or littoral	Environment: Pelagic - living far from shore; Littoral - living near the shore.	Green sunfish are littoral (Moyle 2002).	
bottom or water column distribution	Environment: bottom (benthic) or along water column.	Green sunfish are found throughout the water column (Wang 1986).	
lentic or lotic	Environment: Lentic - pertaining to stagnant water, or lake-like; Lotic - moving water, or river-like.	Green sunfish are lentic.	
Adults			
life span	Approximate maximum age obtained.	Green sunfish live 7 to 9 years; in California, their age at maturity is 1 to 2 years (Wang 1986). Green sunfish can live 10 years, and mature at the beginning of their third year (Moyle 2002).	
adult length	Indicate: Length at which they first reproduce; average length and maximum length the fish can attain.	Green sunfish mature at 2 to 2.8 inches (5 to 7 centimeters) in length (Wang 1986). Green sunfish are rarely greater than 5.9 inches (15 centimeters) in length, reaching 1.2 to 2 inches (3 to 5 centimeters) in their first year, 2 to 3.9 inches (5 to 10 centimeters) in second year, 3.1 to - 5.1 inches (8 to 13 centimeters) in their third year; they can grow up to 11.8 inches (30 centimeters) (Moyle 2002).	
adult weight	Indicate: Weight at which they first reproduce; average weight and maximum weight the fish can attain.	The maximum weight of a green sunfish is 2.2 pounds (1 kilograms) (Moyle 2002).	
physical morphology	General shape of the fish: elongated, fusiform, laterally compressed, etc.	Green sunfish are stouter, but not as deep as other sunfish (Moyle 2002).	
coloration	Indicate color, and color changes, if any, during reproduction phase.	Adult green sunfish are dark olive on the back, becoming lighter on the sides with iridescent green flecks. The sides of green sunfish have colored stripes, the breast and belly are yellow/ orange, and there are green streaks on the cheeks. Both dorsal and anal fins have a large blotch on the rear of the soft rayed portion. Young green sunfish show fine, closely spaced chains of iridescent green. The back, sides, and fins of breeding males	

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		turn very dark, and the fins have bright yellow margins (Moyle 2002).	
other physical adult descriptors	Unique physical features for easy identification.	Green sunfish have large terminal mouths, and the maxillae extend past the front margin of the eye (Moyle 2002).	
adult food base	Indicate primary diet components.	Green sunfish eat invertebrates and small fish (Moyle 2002).	
adult feeding habits	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder.	Green sunfish are active hunters and older fish are territorial for feeding (Moyle 2002).	
adult in-ocean residence time	For anadromous species, age when they migrate to the ocean and duration spent in the ocean before returning to freshwater to spawn.	N/A	
adult habitat characteristics in-ocean	For anadromous species, description of the ocean habitat utilized: whether along major current systems, gyres, pelagic (beyond continental shelves) and neritic (above continental shelves) zones, etc.	N/A	
Adult upstream migration (immigration)			
range of adult upstream migration timing	Time of year adults migrate upstream. If applicable, indicate for various runs.	N/A	
peak adult upstream migration timing	Time of year most adults migrate upstream. If applicable, indicate for various runs.	N/A	
adult upstream migration water temperature tolerance	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	N/A	

Element	Element Descriptor	General	Feather River Specific
adult upstream migration water temperature preference	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.	N/A	
Adult holding (freshwater residence)			
water temperature tolerance for holding adults	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	Green sunfish can survive water temperatures greater than 100.4°F (38°C) (Moyle 2002).	
water temperature preference for holding adults	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.		
water depth range for holding adults	Reported range of observed (minimum and maximum) water depth utilization.		
water depth preference for holding adults	Reported range of most frequently observed water depth utilization.		
substrate preference for holding adults	If bottom dwellers, indicate substrate: mud, sand, gravel, boulders, aquatic plant beds, etc. If gravel, indicate range or average size of gravel.	Green sunfish are associated with shallow, weedy areas, aquatic plants, and muddy bottoms (Moyle 2002).	
water velocity range for holding adults	Reported range of observed (minimum and maximum) water velocity utilization.		
water velocity preference for holding adults	Reported range of most frequently observed water velocity utilization.		
other habitat characteristics for holding adults	General description of habitat (e.g. turbid or clear waters, lentic or lotic, presence of aquatic plant beds, debris, cover, etc.).	Green sunfish inhabit small, warm streams (especially intermittent), ponds, and lake edges. Green sunfish are rare in habitats that contain more than 3 or 4 other species (Moyle 2002).	

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		In Clear Lake, green sunfish are found in beds of tules. In rivers, green sunfish are found in riprap and old car bodies. In Central California, they are abundant in intermittent streams that are warm, turbid, and have muddy-bottomed pools containing beds of aquatic plants. Green sunfish are found in streams that have been heavily disturbed or polluted by human activity (Moyle 2002).	
timing range for adult holding	Time of year (earliest-latest) and duration of stay from upstream migration to spawning.		
timing peak for adult holding	Time of year when maximum number of adults are present before spawning.		
Spawning			
fecundity	Average or range in the number of eggs females lay in a spawning season.	Green sunfish produce 2,000 to 10,000 eggs (Wang 1986). Green sunfish produce 2,000 to 10,000 eggs (Moyle 2002).	
nest construction	Location and general description of nest -- substrates, aquatic plants, excavations, crevices, habitat types, etc.	Green sunfish build nests near protected coves (Wang 1986).	
nest size	Size and average dimensions of the nest.	Green sunfish nests range from 5.9 to 14.9 inches (15 to 38 centimeters) in diameter (Moyle 2002).	
spawning process	Indicate whether nest builder, broadcast spawner, or other.	Male green sunfish mate with numerous females on the same or different nests (Wang 1986).	
spawning substrate size/characteristics	Range of substrates used during spawning (e.g., mud, sand, gravel, boulders, beds of aquatic plants). Indicate presence of plant/wood debris, crevices at spawning sites. If gravel, indicate range of average size.	Green sunfish spawn on gravel, clumps of vegetation, rock or among the branches of fallen trees (Wang 1986). Green sunfish spawn on fine gravel bottoms near overhanging bushes or other cover (Moyle 2002).	

Element	Element Descriptor	General	Feather River Specific
preferred spawning substrate	Indicate preferred spawning substrate (e.g., mud, sand, gravel, boulders, plant bed, etc).		
water temperature tolerance for spawning	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	The water temperature range for spawning green sunfish is 68°F to 82.4°F (20°C to 28°C) (Wang 1986). Green sunfish spawn in water temperatures ranging from 59°F to 82.4°F (15°C to 28°C), although in California, spawning does not begin until water temperatures reach 66.2°F (19°C) (Moyle 2002).	
water temperature preference for spawning	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
water velocity range for spawning	Minimum and maximum speed of water current the spawning fish can tolerate.		
water velocity preference for spawning	Preferred water current (flow velocity) during spawning.		
water depth range for spawning	Reported range of observed (minimum and maximum) water depth utilization.	Green sunfish spawn at depths of less than 19.7 inches (0.5 meters) (Wang 1986). Green sunfish build nests in water 1.6 to 19.7 inches (4 to 50 cm) deep (Moyle 2002).	
water depth preference for spawning	Reported range of most frequently observed water depth utilization.		
range for spawning timing	Earliest and latest time of season or year in which spawning occurs.	Green sunfish spawn from May through August, and from early June to mid-August in Colorado (Wang 1986). Green sunfish spawn from May through August (Moyle 2002).	
peak spawning timing	Time of year most fish start to spawn.	Peak spawning of green sunfish occurs in May and June (Moyle 2002).	

Element	Element Descriptor	General	Feather River Specific
spawning frequency (iteroparous/semelparous)	Semelparous - producing all offspring at one time, such as in most salmon. Usually these fish die after reproduction. Iteroparous - producing offspring in successive, e.g., annual or seasonal batches, as is the case in most fishes.	Female green sunfish turn on their side, vibrate, and release eggs while the male remains alongside releasing sperm (Moyle 2002).	
Incubation/early development			
egg characteristics	Shape, size, color, in clusters or individuals, stickiness, and other physical attributes.	Green sunfish eggs are spherical, 0.03 to 0.05 inches (1.0 to 1.4 millimeters) in length, yellowish, granular, transparent, elastic, very adhesive, demesal, and deposited singly or in small clusters on the nest (Wang 1986). Green sunfish eggs are adhesive and demersal and egg development is similar to that of a bluegill (Taubert 1977).	
water temperature tolerance for incubation	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	Green sunfish eggs were collected at water temperatures of 66.2°F to 75.2°F (19°C to 24°C) (Wang 1986). Water temperatures for green sunfish eggs range from 75.2°F to 80.6°F (24°C to 27°C) and are hatched in 35 to 55 hours (Taubert 1977).	
water temperature preference for incubation	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
time required for incubation	Time duration from fertilization to hatching. Note: Indicate at which temperature range. Incubation time is temperature-dependent.	Green sunfish eggs hatch in 3 to 5 days at unspecified temperatures (Wang 1986). Green sunfish eggs hatch in 3 to 4 days at water temperatures of 66.2°F to 73.4°F (19°C to 23°C) (Wang 1986).	
size of newly hatched larvae	Average size of newly hatched larvae.	Green sunfish larvae are 0.13 to 0.15 inches (3.2 to 3.7 millimeter) in length (Wang 1986). Green sunfish larvae are 0.13 to 0.15 inches (3.5 to 3.7 millimeters) in length (Taubert 1977).	

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time newly hatched larvae remain in gravel	Time of year of hatching, and duration between hatching and emergence from gravel.		
other characteristics of larvae	Alevin -- early life history phase just after hatching (larva) when yolk-sac still present.	Green sunfish larvae swim among crevices in gravel for 1 to 2 days and swim freely 3 to 4 days after hatching (Wang 1986).	
timing range for emergence	Time of year (earliest-latest) hatchlings (larvae and alevins) leave or emerge from the nesting/hatching (gravel) sites.	Male green sunfish guard the embryos for 5 to 7 days, enough time for the young to hatch and become free swimming (Moyle 2002).	
timing peak for emergence	Time of year most hatchlings emerge.		
size at emergence from gravel	Average size of hatchlings at time of emergence.		
Juvenile rearing			
general rearing habitat and strategies	General description of freshwater environment and rearing behavior.		
water temperature tolerance for juvenile rearing	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for juvenile rearing	Range of suitable, preferred, or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
water velocity ranges for rearing juveniles	Reported range of observed (minimum and maximum) water velocity utilization.		
water velocities preferred by rearing juveniles	Reported range of most frequently observed water velocity utilization.		

Element	Element Descriptor	General	Feather River Specific
water depth range for juvenile rearing	Reported range of observed (minimum and maximum) water depth utilization.		
water depth preference for juvenile rearing	Reported range of most frequently observed water depth utilization.		
cover preferences for rearing juveniles	Type of cover for protection from predators used by rearing juveniles (e.g. crevices, submerged aquatic vegetation, overhanging vegetation, substrate cover, undercover bank, small woody debris, large woody debris).	Juvenile green sunfish are found in shallow, still, or low-velocity waters of the Sacramento-San Joaquin river system (Wang 1986). Juvenile green sunfish inhabit small ponds with dense vegetation, ditches with filamentous algae, and nearshore areas of large reservoirs (Wang 1986).	
food base of juveniles	Indicate primary diet components. Also indicate the diet changes, if any, as growth occurs.	Juvenile green sunfish eat crustaceans, aquatic insects, larvae, and terrestrial insects (Wang 1986). Young-of-year green sunfish feed on zooplankton and small benthic invertebrates such as chironomid midge larvae and mayfly larvae. As juvenile green sunfish mature, they feed on large aquatic insects, dragonfly larvae, terrestrial insects, crayfish, and fish (Moyle 2002).	
feeding habits of rearing juveniles	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder. Also indicate change of feeding habits growth occurs.	Juvenile green sunfish are active hunters (Moyle 2002).	
predation of juveniles	Indicate which species prey on juveniles.	Juvenile green sunfish are preyed upon by largemouth bass and other piscivores (Moyle 2002).	

Element	Element Descriptor	General	Feather River Specific
timing range for juvenile rearing	Range of time of year (months) during which rearing occurs.		
timing peak for juvenile rearing	Time of year (months) during which most rearing occurs.		
Juvenile emigration			
time spent in fresh water prior to emigrating	Duration (in years and/or months) from emergence to emigration to the ocean.	N/A	
water temperature tolerances during emigration	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	N/A	
water temperature preferences during emigration	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.	N/A	
emigration timing range	Time of year juveniles commence emigration and duration of emigration.	N/A	
emigration timing peak	Time of year most juveniles are emigrating.	N/A	
size range of juveniles during emigration	Minimum and maximum sizes (inches or mm) of emigrating juveniles. Indicate average size.	N/A	
factors associated with emigration	Pulse flows, water temperature changes, turbidity levels, photoperiod, etc.		
Other potential factors			
DO	Levels of dissolved oxygen in water expressed in mg/l tolerated by fish.	Green sunfish tolerate dissolved oxygen (DO) levels less than 4.0 mg/L (Wang 1986). Green sunfish tolerate DO levels less than 1 mg/L (Moyle 2002).	

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pH	Alkalinity/acidity of water (expressed in pH) that fish can tolerate.	Green sunfish can tolerate alkalinities up to 2,000 mg/L (Moyle 2002).	
turbidity	Indicate turbidity or state of water (e.g., clear water or presence of siltation or organic/inorganic matter in water) that fish can tolerate.	Green sunfish are a pioneer species and are capable of surviving where other species cannot (Moyle 2002).	
factors contributing to mortality	e.g., fishing/angling mortality, drastic habitat alterations, unfavorable climatic changes, etc.		

References

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